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Principal Component Analysis for Rice Characters Relating with Plant Statues and Yield

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Summary

Principal component analysis for 9 structural characters of 53 rice varieties in 1985, 30 rice varieties in 1986 reconfirmed their ecospecific difference. Cumulative contribution of the three component accunted for 83.07 and 83.41 of total varition in 1985 and 1986, respectively. The first principal component was considered to be a factor relating with plant and panicle size, the secnnd relating with ripening. and the third relating with grain size.

Many *japonica* varieties showed panicle number type with short culms and relatively high ripening percentages. *Indica* varieties showed panicle weight type related to long culms and a few panicles. Hewever, the plant type of *indica* varieties e. g. IR-8, Dee-Geo-Woo-Gen and Taichung Native 1 resembled to that of *japonica* varieties. Korean varieties which are *japonica-indica* hybrid also resembled to *japonica* group. *Javanica* and large grain varieties showed a plant type of long and thick culm, large panicle with big spikelets and relatively low ripening percentages. Of *japonica* ecospecies, landraces e. g. Aikoku and Somewake had relatively longer culm and larger panicle with lower ripening percentage than other *japonica* varieties, while improved varieties e. g. Koshihikari, Reimei and Sasanishiki showed higher grain yield and ripening. Comparing the results in 1985 with those in 1986, ripening percentage was higher in 1986 especially in *indica* varieties although the number of panicles was almost the same as that in 1985. The high ripening percentage in 1986 may be attributed to high solar radiation with a long sunshine duration in September.

Introduction

Rice varieties used in the current experiments consist of 3 ecospecies, i. e. *japonica*, *indica*, and *javanica*. The first grouping of rice varieties were carried out by Kato[1] He recognized two groups, i. e. "Indian" and "Japanese" based on the geographical distribution, morphological characters and hybrid sterility. Japanese workers investigated differences between the ecospeies[3,9,12]. Among the many characters with which one can distinguish the ecospecies, the length/width ratio of seeds is an efficient measure for grouping *japonica* and *indica*[3]. Morinaga[6] classified 4 ecotypes i. e. *aus*, *aman* and *boro* which belongs to *indica*, bulu which belongs to *javanica* and *japonica* due to hybrid fertility and geographical distribution. Recently, *indica-japonica* difference has been quantitatively distinguished on the basis of character-association patterns and the integration of various characters i. e. quantitative, morphological and physiologcal properties[8~10]. The objective of the present study is to clarify the difference between ecospecies and that between indigeneous and improved varietes, especially with reference to yield components.

Materials and Methods

Fifty three rice varieties in 1985 and 30 varieties in

1986 were grown in an expermental field of Biological Engineering Laboratory of Asahi Industries Co. LTD. at Kamikawa-machi in Saitama. In 1985, 23 *japonica*, 11 *javanica* and 22 *indica* varieties which included indigeneous and improved vatieties. In 1986, 30 varieties were chosen from 53 varieties used in 1985 (Table 1) due to the culture conditions at the above mentioned place. Rice seeds were sown on May 11 and

Table 1. Rice varieties used in the experiments.

Japonica	Indica	Javanica
1. Aikoku	1. Josaeng Tongil	*1. Allorio
*2. Akihikari	*2. Tongil	*2. Arditane
3. Akibare	*3. Milyang 23	*3. Arborio
*4. Calrose	*4. Dee-Geo-Woo-Gen	4. Lomelto
*5. Fujisaka 5	*5. Taichung Native 1	*5. Rizzotto
*6. Fujiminori	*6. IR-8	6. Senatore Novelli 19
7. Hatsunishiki	*7. Ambar	7. Secia
8. Hoyoku	*8. Blue Belle	8. Stirpe 136
*9. Ishikari	*9. Blue Bonnet	*9. Lady Wright
*10. Koshihikari	10. Kinandang Item	10. BG-1
11. Kameji	*11. Panbira	11. BG-4
12. Kotaketamanishiki	12. Shilewah	
*13. Kinmaze	*13. Tadukan	
*14. Norin 11	*14. Zenith	
15. Rikuu 132	*15. Chokoto	
*16. Reimei	16. Dojinkyo	
*17. Sasanishiki	17. Kannonsen	
*18. Sasashigure	18. Keikyakusen	
19. Sakaikaneko	19. Konansen	
*20. Somewake	20. Kosen	
*21. Taichung 65		
22. Toyonishiki		

Note : Fifty-three varieties were used in 1985 and 30 varieties indicated with * in 1986.

Table 2. Meterological data at kumagaya in 1985 and 1986.

Parameters	Year	Month				
		5	6	7	8	9
Mean Temp. (℃)	1985	18.5	19.7	25.7	27.5	22.1
	1986	17.5	20.5	23.1	26.1	22.6
Sunshine duration (h)	1985	203.4	113.2	194.9	238.5	118.8
	1986	201.0	140.7	106.4	187.2	145.5
*Global solar radiation (MJ/m^2)	1985	161	120	166	164	104
	1986	142	123	154	125	118

* : Data of solar radiation was quoted form Annual Report of the Japan Meterological Agency in 1985 and 1986 for Maebashi near Kumagaya and experimental place.

Table 3. Ecotypical variation in mean values of rice characters including 53 varieties in 1985.

Ecospecies	Culm length (cm)	Panicle length (cm)	Number of panicles	Top dry weight (g)	Panicle weight (g)	Nomber of spikelets	Number of ripened grains	R. P. (%)	1000 grain weight (g)	Yield (g/m²)
japonica	111.4 ±15.5	20.5 ±2.5	16.4 ±4.8	5.6 ±1.4	2.7 ±0.7	129.5 ±35.3	87.0 ±27.5	68.2 ±15.1	22.4 ±1.0	725.9 ±312.5
javanica	127.2 ±8.4	22.1 ±1.9	10.7 ±3.4	7.3 ±1.4	3.6 ±0.9	118.1 ±24.4	68.2 ±17.8	57.7 ±8.4	34.0 ±6.7	532.0 ±218.5
indica	164.0 ±35.6	26.9 ±3.7	13.3 ±5.6	8.3 ±3.1	3.8 ±1.4	216.9 ±92.5	96.2 ±51.5	44.7 ±17.6	21.7 ±4.9	548.4 ±300.9

Fifty three varieties, 22 of *japonica*, 14 of *javanica* or large grain type, and 20 of *indica* varieties were used. The figures are mean values with standard deviation. Abbreviation ; R. P. : Ripening percentage.

Table 4. Ecotypical variation in mean values of rice characters including 30 varieties in 1986.

Ecospecies	Culm length (cm)	Panicle length (cm)	Number of panicles	Top dry weight (g)	Panicle weight (g)	Nomber of spikelets	Number of ripened grains	R. P. (%)	1000 grain weight (g)	Yield (g/m²)
japonica	103.5 ±18.3	20.4 ±4.3	19.4 ±5.1	6.3 ±2.2	3.3 ±1.2	139.2 ±46.2	113.9 ±42.0	80.0 ±9.0	22.6 ±1.3	1117.0 ±524.5
javanica	125.8 ±10.1	20.6 ±1.9	10.1 ±1.3	9.0 ±0.4	3.9 ±0.7	125.0 ±16.4	99.4 ±19.3	79.1 ±8.9	28.5 ±5.4	635.6 ±175.4
indica	127.6 ±38.1	25.4 ±2.8	14.3 ±5.0	8.8 ±2.7	4.4 ±1.5	234.5 ±108.8	161.0 ±66.4	71.6 ±19.1	21.2 ±5.6	933.0 ±233.0

Fifty three varieties, 13 of *japonica*, 5 of *javanica* or large grain type, and 12 of *indica* varieties were used. The figures are mean values with standard deviation. Abbreviation ; R. P. : Ripening percentage.

Table 5. Variance analysis of 9 rice characters in 1985.

Source of variance	Degree of freedom	Culm length	Panicle length	Number of panicles	Top dry weight	Panicle weight	Number of spikelets	Number of ripened grains	Ripening percentage	1000 grain weight
Variety	52	1626.310**	31.036**	56.026**	11.916**	2.491**	11419.400**	2865.020**	651.852**	113.750**
Replication	1	7.931	0.715	1.534	0.404	0.119	138.028	91.161	13.751	8.464
Error	52	128.558	23.206	13.838	7.044	3.338	160.504	87.704	57.825	24.784

** : Significant at 1 % level.

Table 6. Variance analysis of 9 rice characters in 1986.

Source of variance	Degree of freedom	Culm length	Panicle length	Number of panicles	Top dry weight	Panicle weight	Number of spikelets	Number of ripened grains	Ripening percentage	1000 grain weight
Variety	29	1688.190**	33.720**	65.850**	13.086**	3.568**	15814.400**	5215.340**	404.167**	46.378**
Replication	1	7.195	1.758	1.340	0.485	0.062	140.733	202.404	52.592	0.134
Error	29	116.912	22.426	15.800	7.791	3.815	175.042	122.495	77.111	22.985

** : Significant at 1 % level.

transplanted on June 12 in 1985, and May 15 and June 14 in 1986, respectively. One seedling per hill was planted in a planting density of 30 × 15 cm, and 45 plants per variety were planted in 3 rows with two replications. Sixty seven kg of nitrogen, 81 kg of phosphoric acid and 79 kg of potassium per ha were fertilized in each year. The plants were irrigated periodically. Six plants per variety were sampled from the middle row excluding the peripheral two rows after full grain filling. After drying the materials at room temperature, eight characters i. e. culm length, panicle length, number of panicles, top dry weight, panicle weight, number of spikelets, number of ripened grains and 1,000 grain weight were measured. Ripening percentage and grain yield were calculated from number of spikelets, number of ripened grains and other characters of the yield components. The data for 9 characters excluding grain yield were subjected to the principal component analysis.

Results

The meterological data during the rice cropping sea-

Table 7. Factor loadings of the first three principal components for 53 varieties in 1985.

Characters	Principal components I	II	III
Culm length	0.745	−0.452	0.004
Panicle length	0.076	−0.413	−0.118
No. of panicles	−0.428	0.043	−0.655
Top dry weight	0.935	0.131	0.204
Panicle weight	0.854	0.349	0.188
No. of spikelets	0.904	0.100	−0.265
No. of ripened grains	0.566	0.775	−0.148
Ripening percentage	−0.345	0.831	0.165
1000 grain weight	0.188	−0.120	0.886
Cumulative contribution	46.82	67.20	83.07

Table 8. Factor loadings of the first three principal components for 30 varieties in 1986.

Characters	Principal components I	II	III
Culm length	0.767	0.093	0.237
Panicle length	0.825	−0.094	−0.087
No. of panicles	−0.413	−0.568	−0.453
Top dry weight	0.931	0.207	0.148
Panicle weight	0.927	0.165	−0.142
No. of spikelets	0.880	−0.358	0.073
No. of ripened grains	0.897	−0.093	−0.381
Ripening percentage	−0.013	0.607	−0.761
1000 grain weight	−0.196	0.849	0.185
Cumulative contribution	53.22	71.43	83.41

Table 9. Simple correlations between 10 characters of 53 rice varieties in 1985.

Characters	Culm length	Panicle length	Number of panicles	Top dry weight	Panicle weight	Number of spikelets	Number of ripened grains	R. P.	1000 grain weight	Yield
Culm length										
Panicle length	0.810**									
Number of panicles	−0.231	−0.233								
Top dry weight	0.645**	0.565**	−0.459**							
Panicle weight	0.434**	0.413**	−0.374**	0.924**						
Number of spikelets	0.523**	0.597**	−0.256	0.810**	0.768**					
Number of ripened grains	0.098	0.208	−0.104	0.547**	0.670**	0.590**				
R. P.	−0.483**	−0.512**	0.120	−0.208	−0.051	−0.366**	0.458**			
1000 grain weight	−0.038	−0.144	−0.277*	0.007	0.005	−0.425**	−0.299*	0.129		
Yield	−0.214	−0.169	0.566**	0.043	0.220	0.047	0.598**	0.602**	−0.033	

* : Significant at 5 % level
** : Significant at 1 % level
Abbreviation ; R. P. : Ripening percentage.

Table 10. Simple correlations between 10 characters of 30 rice varieties in 1986.

Characters	Culm length	Panicle length	Number of panicles	Top dry weight	Panicle weight	Number of spikelets	Number of ripened grains	R. P.	1000 grain weight	Yield
Culm length										
Panicle length	0.656**									
Number of panicles	−0.327	−0.118								
Top dry weight	0.747**	0.700**	−0.541**							
Panicle weight	0.572**	0.704**	−0.418*	0.891**						
Number of spikelets	0.590**	0.702**	−0.201	0.736**	0.785**					
Number of ripened grains	0.522**	0.709**	−0.282	0.723**	0.808**	0.764**				
R. P.	−0.070	−0.05	−0.052	−0.012	0.157	−0.337	0.127			
1000 grain weight	−0.004	−0.134	−0.270	0.020	−0.041	−0.480**	−0.345	0.302		
Yield	0.040	0.410*	0.633**	0.102	0.327	0.215	0.279	0.317	−0.108	

* : Significant at 5 % level
** : Significant at 1 % level
Abbreviation ; R. P. : Ripening percentage.

son in 1985 and 1986 at Kumagaya near the experimental place in Saitama prefecture were presented in Table 2. In 1986, sunshine duration is long in June and September and in 1985, May, June, and August.

Mean values and standarad errors for the characters measured for *japonica*, *javanica* and *indica* were presented in Table 3 and 4. In 1985 and 1986, culm length, panicle lengh, top dry weight, panicle weight, number of spikelets and number of ripened grains were higher in *indica* than in *japonica*. Whereas, number of panicles, ripening percentage and grain yield were higher in *japonicas* than in *indicas*. Of *indica* varieties, the traits of the above-mentioned characters of IR-8, Dee-Geo-Woo-Gen and Taichung Native 1 were similar to *japonicas*. They showed panicle number type with short culm. Korean varieties i. e. Josaeng Tongil, Tongil and Milyang 23 which are the descendants of Dee-Geo-Woo-Gen, IR-8 and a *japonica* variety, Yukara are also similar to their progenitor, Dee-Geo-Woo-Gen. *Javanicas* and large grain varieties showed intermediate traits between *japonicas* and *indicas* except for 1,000-grain weight. Almost all the *javanica* varieties showed larger grain sizes.

The analyses of variance for 9 characters relating with rice structure and yield components were presented in Table 5 and 6. The differences between varieties in 9 characters were highly significant in both 1985 and 1986. All the variances doe to replication were not significant.

Factor loadings and cumulative contributions in the principal component analyses for 9 characters are shown in Table 7 and 8. When totalled, the first three components (I, II, and III) could account for 83.07 and 83.41% of the total variation in 1985 and 1986,

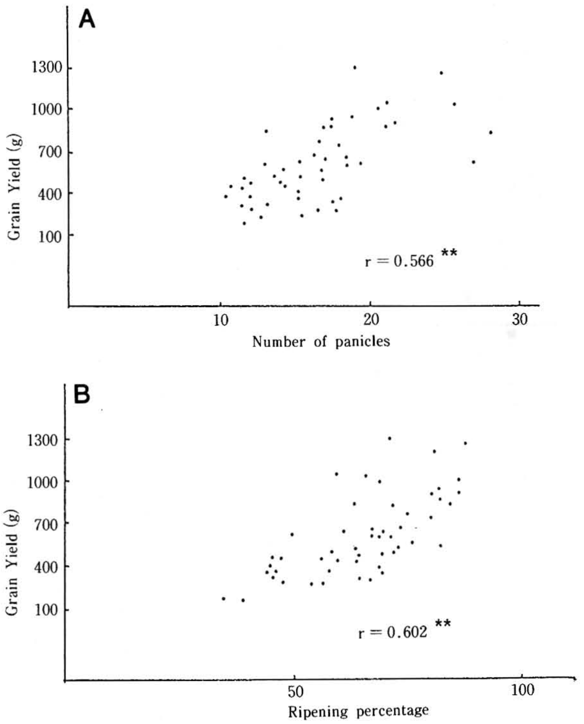


Fig. 1. Relationship of grain yield to nember of panicles (A), and to ripening percentage (B) in 1985.

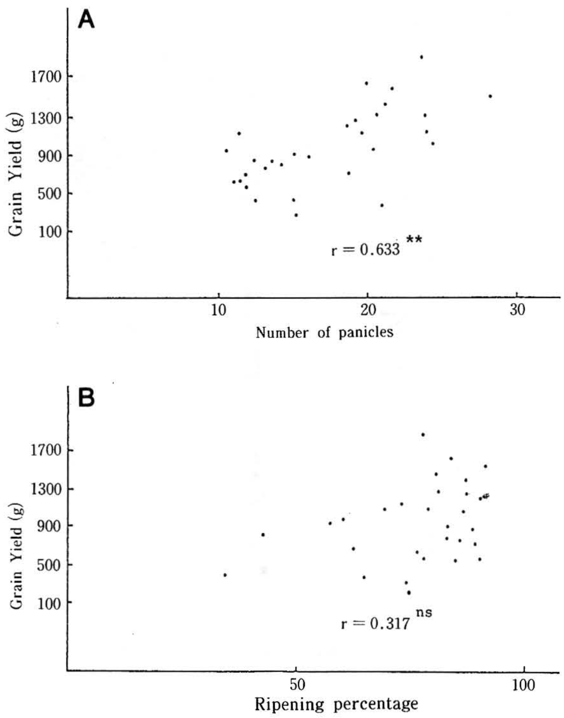


Fig. 2. Relationship of grain yield to nember of panicles (A), and to ripening percentage (B) in 1986.

respectively. Culm length, panicle length, top dry weight, panicle weight, number of spikelets, and number of ripened grains showed highly positive factor loadings in the first principal component in both 1985 and 1986. Thus, the first principal component was considered to be a factor relaing with plant size. In the second principal component, the number of ripened grains and ripening percentage showed highly positive factor loadings in 1985, while ripening percentage and 1,000-grain weight were highly positive in 1986. Hence, the second principal component was considered to be a factor relating with grain filling. In the third principal component, 1,000-grain weight showed a positve loading factor in 1985, Thus, the third princhpal component was considered to be a factor of grain size. Whereas the value for 1,000-grain weight was not necessarily high and that of ripening percentage was highly negative in the third principal component in 1986.

Simple correlations between 10 rice characters concerning plant structures and yield components in 1985 and 1986 are shown in Table 9 and 10, respectively. Grain yield was closely correlated (1 % level) with number of ripened grains and ripening percentage as well as number of panicles in 1985 (Fig. 1) . However in 1986, the number of ripened grains and ripening percentage were not correlated with grain yield although the number of panicles was significantly correlated with grain yield (Fig. 2).

Scatter diagrams for principal component analysis in

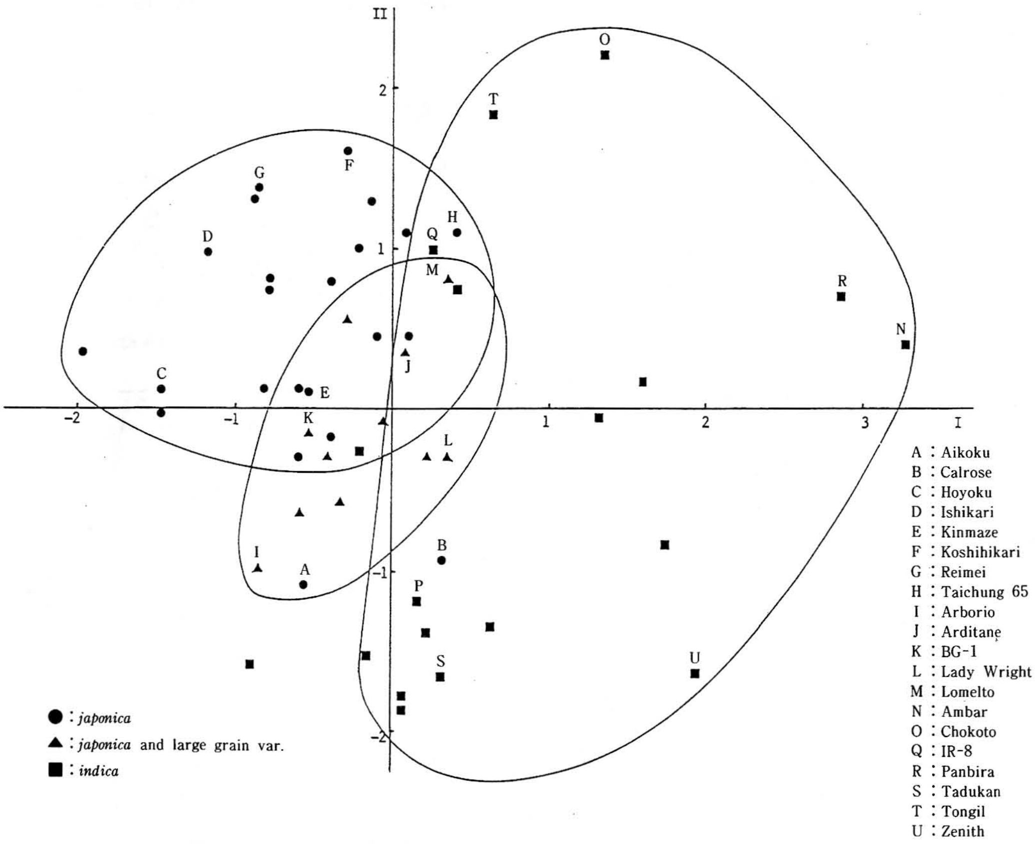
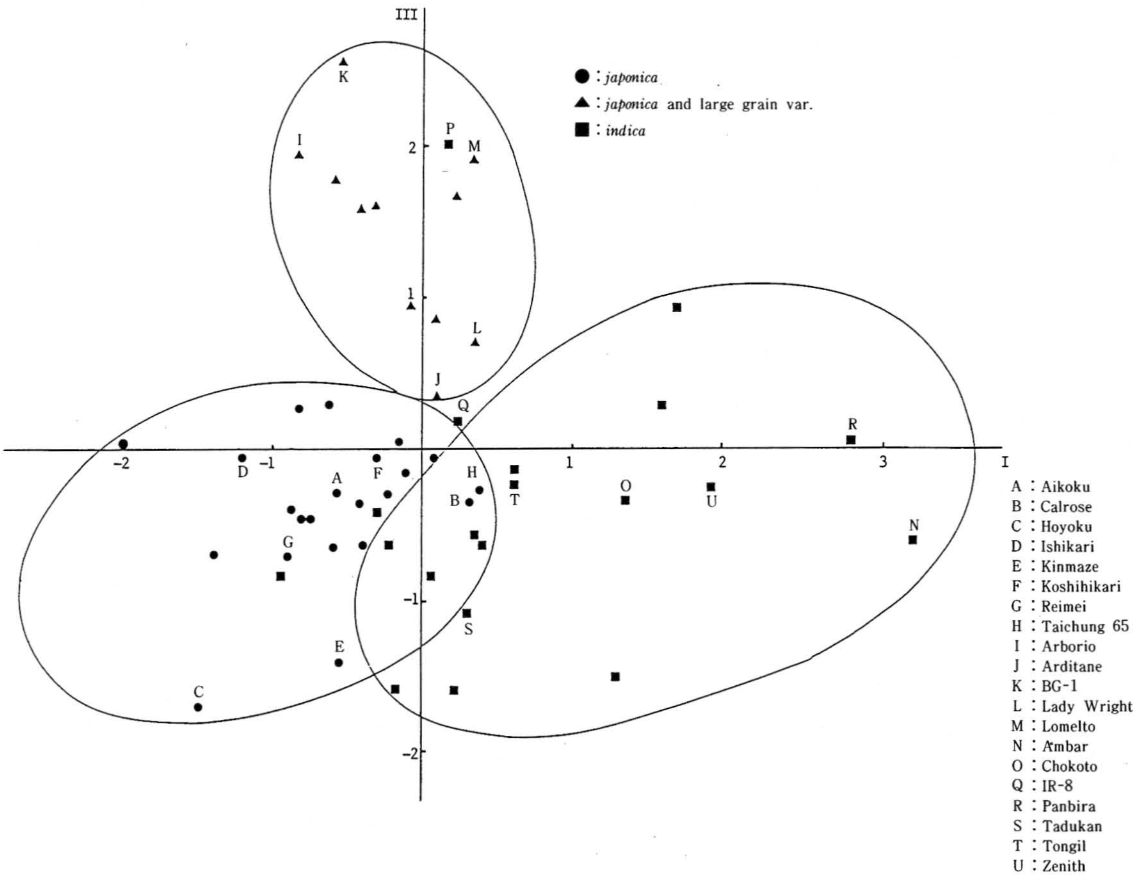


Fig. 3. Scatter diagram of 53 rice varieties in a plaine defined by the first (I) and second (II) principal component in 1985.



Fia. 4. Scatter diagram of 53 rice varieties in a plaine defined by the first (I) and third (III) principal component in 1985.

1985 are shown in Figs 3 and 4. The two plant types, i. e. panicle weight type and panicle number type were distinguished in Fig. 3. In Fig. 3, many *japonica* varieties were characterized to be the panicle number type with small plant size, i. e. short culm and small to middle panicle with relatively high ripening percentage. In *japonicas*, impoved varieties, e. g. Reimei and Koshihikari showed high ripening percentages while indigeneous varieties, e. g. Aikoku and Somewake showed low ripening percentages. The *indicas* could be classified into 3 groups. The first group was characterized by high ripening percentages with short to intermediate plant height, in which IR-8, Dee-Geo-Woo-Gen and Korean varieties, e. g. Tongil, Josaeng Tongil and Milyang 23 were included. The second group was characterized by long culms and panicles with relatively low ripening percentages. The third group was distinctive to be with low ripening percentage in which chinese *indica*, i. e. Konansen, Keikakusen and Chokoto were included. Scatter diagram in a plane defined by the first and second principal component in 1986 is shown in Fig. 5. Characteristics of *japonica*, *indica*, and *javanica* were similar to the results in Fig. 3. *Japonica* varieties showed a similar pattern as in 1985, while ripening percentage of *indica* varieties considerably increased in 1986. *Javanica* varieties showed higher grain filling and 1,000-grain weight in 1986.

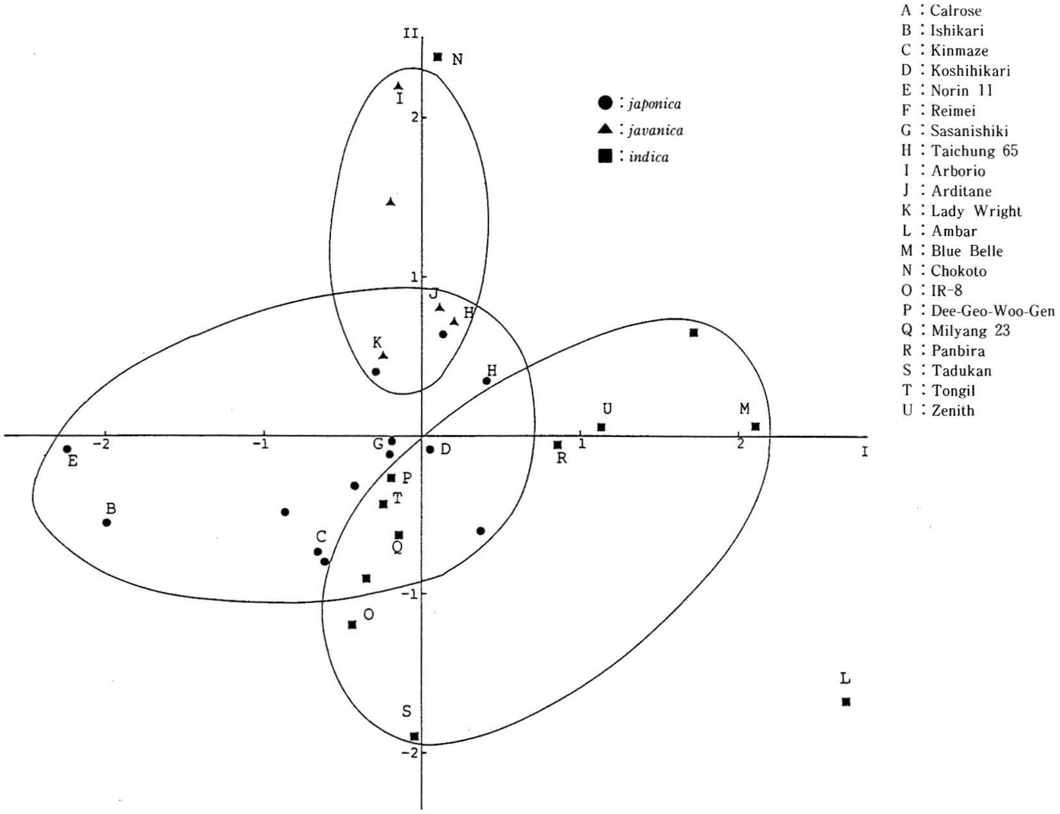


Fig. 5. Scatter diagram of 30 rice varietes in a plaine defined by the first (I) and second (II) principal component in 1986.

Discussion

The method of principal component analysis is known to be of use for classifying varieties. Sasahara *et al.*[8] showed a high integration of alpha-amylase activity together with a high top dry weight and relative growth rate in the principal component analysis using 36 varieties which belong to 3 ecospecies. Kondo and Futsuhara[2] classified types of panicle density by analysis of component characters using lax and denes panicle lines in *japonica* varieties.

In the study concerned with the differentiation of rice ecospecies, Morishima and Oka[8] clearly distinguished two ecospecies, i. e. *japonica* and *indica* types in the principal component analysis for 11 characters. They also showed that discriminant functions combining the 3 or 4 character proved to give a lower probability of misclassification. In the analysis of F_3 lines obtained from a cross between tall and short varieties, i. e. Peta and I-g-t, Morishima *et al.*[7] reported that yield potential was negatively correlated with plant type score, the short lines being more productive than the tall lines. Furthermore, panicle number type as well as internode length type seemed to relate with higher yielding potential than panicle weight type and internode number type. In this experment, rice varieties could be classified and characterized by the principal component analysis for structural and yield-determining characters of 53 and 30 rice varieties in 1985 and 1986, respectively. The present results clarified that many *japonica* varieties showed panicle number type with short culm, highly ripening percentage and high yielding property, while many *indica* varieties showed panicle weight type with long and a few panicles. Grain yield of the latter decreased more severely than that of the former under a inadequate climate condition at ripening stage as in 1985.

Based on the results of defoliation and root-pruning experiments, Matsushima[5] reported a very strong positive correlation ($r = 0.99$) between yield and percentage of ripened grains. He also indicated that the grain yield was dependent mainly upon the percentage of ripened grains especially after determination of the number of panicles and the number of spikelets per panicle. In the present study, correlation between grain yield and ripening percentage was also higher ($r = 0.60$) than the correlation between grain yield and other characters for 53 rice varieties in 1985. However, the correlation between grain yield and ripening percentage for 30 varieties in 1986 was not significant. The different results in 1985 and 1986 may be attributed to the difference in climate such as sunshine duration and solar radiation at the middle to late ripening stages. Solar radiation during the middle to late ripening stages in 1985 was lower than in 1986, and the tall varieties of *indica* type slightly lodged in 1985, although the climatic conditions at early vegetative stages in this year were more suitable for rice growth and anthesis. Ripening percentage was generally low in 1985 as compared with that in 1986. The improved and high yielding varieties could secure high percentages of ripened grains even in those inadequate climatic conditions. As a close relation between the ripening percentage and the amount of solar radiation was reported by Matsushima[5], the grain yield is dependent mainly upon ripening percentage especially under a low solar radiation during the ripening period as in 1985. In such climatic conditions, it is important to secure a high percentage of ripened grain to increase grain yield. In contrast, contribution of yield components to the grain yield in 1986 differed from that in 1985. Under a good climatic condition in which a relatively high ripening percentage could be achieved as in 1986, it is of importance to secure a suitable number of panicles.

Matsuo *et al.*[4] reported that indigenous varies had traits of longer culms and few panicles and showed wide variations as *indica* rice, while improved varieties had the opposite traits. Furthermore, they reported that some of indigenous varieties in *japonicas* reacted positively to phenol and negatively to KOH as in many *indica* varieties, although *japonica* improved varieties did not react to phenol and reacted positively to KOH. In this experment, the difference between improved and indigeneous varieties are also recognized. That is improved varieties could be classified as the panicle number type with high ripening percentaqes, in contrast with indigenous varieties which are panicle weight type with low ripening percentage. Current varieties of *japonica* appeared to be improved toward short culm, many panicles, high ripening percentage, and high grain yield.

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Literature Cited

1) Kato, S., H. Kosaka and S. Hara (1928). On the affinity of rice vrieties as shown by fertility of hybrid plants. Contri. Agron. Inst. Kyushu Imp. Univ., Japan 3 : 132-147
2) Kondo, S. and Y. Futsuhara (1980). Genetic studies on the panicle formation in rice. I. Analysis of component characters of panicle density. Japan. J. Breed. 30 : 335-343
3) Mtsuo, T. (1952). Genecological studies on cultivated rice. Bull. Nat. Inst. Agr. Sci., Japan, D 3 : 1-111
4) Matsuo, T., K. Hasegawa and T. Yamada (1959). Some characters of indigenous rice varieties in Japan. Japan. J. Breed. 9 : 93-96
5) Matsushima, S. (1979). Crop science in rice-Theory of yield determination and its application. Fuji Publ., Tokyo
6) Morinaga, T. (1968). Origin and geographical distribution of Japanese rice. Japan. Agr. Res. Quart.

3：1-5

7) Morishima, H., H. I. Oka and T. T. Chang (1966). Analysis of genetic variations in plant type of rice. 1. Estimation of indices showing genetic plant type and their correlations with yielding capacity in segregating population. Japan. J. Breed. 17：73-74

8) Morishima, H. and H. I. Oka (1981). Phylogenetic differentiation of cultivated rice, XXII. Numerical evaluation of the *indica-japonica* differentiation. Japan. J. Breed. 31：402-413

9) Oka, H. I. (1953). Phylogenetic differentiation of cultivated rice 1. Variations in various characters and character combinations among rice varieties. Japan J. Breed. 3：33-43

10) Oka, H.I. (1958). Intervarietal variation and classification of cultivated rice. Ind. J. Genet. & P1. Breed. 18：79-89

11) Sasahara, T., H. Ikarashi and M. Kambayashi (1986). Genetic variations in embryo and endosperm weights, seedling growth parameters and alpha-amylase activity of the germinated grains in rice (*Oryza sativa* L.). Japan. J. Breed. 36：248-261

12) Terao, H. and U. Midusima (1939). Some considerations on the classification of *Oryza sativa* L. into two subspecies, so called *japonica* and *indica*. Jpn. Jour. Bot. 10：213-258

イネ植物体構成形質に関する主成分分析

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摘　　要

日本型イネ22，ジャワ型および大粒種11，インド型イネ20の合計53品種(1985年)および日本型13，ジャワ型5，インド型12の30品種(1986年)を供試し植物体構成の品種・生態種間差異を調査した．種子は5月11日(1985年)および5月15日(1986年)に播種し苗は1ケ月後に移植，9月下旬より成熟した個体から順々にサンプリングし日陰で十分乾燥した後に諸形質を測定した．肥料は元肥に10 a 当たりN4.8kg，P7.2kg，K 6.4kgを施用した．調査は稈長，穂長，茎数，地上部重，穂重，一穂穎花数，登熟粒数，登熟歩合，玄米千粒重および収量の10形質について行った．表3および表4に各形質について品種の平均を生態種ごとに示した．収量を除く9形質の分散分析の結果，9形質のすべてに品種間で有意な差異(1％レベル)が認められた(表5および表6)．またこれらの形質のうち収量を除く9形質の形質間相関を用いて主成分分析をおこなった．第3主成分までの因子負荷量および累積寄与率を表7および表8に示した．第1主成分は稈長，地上部重，穂重，一穂穎花数が高い正の値を示すことから，穂をふくめて植物体の大きさや穂重型・穂数型の対比を示す成分であり，第2主成分は登熟歩合が高い正の値を示すことから登熟の良否を示す成分，また第3主成分は千粒重が高い正の値，穂数や粒数で負の値を示すことから粒サイズを示す成分であると考えられた．スコア散布図(図3～図5)より日本型イネは植物体の大きさは小から中であり穂数型が多く，千粒重が21～23 g と比較的小粒で登熟は平均して良好であった．インド型イネは一部の半矮性系統を除き長稈・長穂で穂重型が多く，粒サイズは日本型と同程度かそれよりも小粒のもの(千粒重20 g 以下)が多かった．インド型に含めた品種のうちIR-8，低脚烏尖，台中在来1号および韓国の品種は日本型と同様の特性を示した．登熟に関してインド型の品種は大きなばらつきを示し，一般に日本型と比較して不良なものが多かったが，改良の進んだ一部の品種に良好なものがあった．ジャワ型イネの各種形質は大粒であるということを除けば，日本型とインド型の中間を示した．1985年と1986年とを比較して1986年の方が登熟が良好であったが，特にジャワ型およびインド型品種で著しい向上を示した．これは1986年の9月すなわち登熟中後期の日射量が多かったためと推測された．またスコア散布図から日本型品種の中でも在来品種と改良種に分けることが出来た．在来品種は比較的に長稈で穂重型の傾向にあり登熟歩合もやや不良であったが，改良品種は比較的に短稈で穂数型の傾向にあり登熟歩合も良好であった．